IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Ling-Chi LIAW et al. Group Art Unit: 1763

Serial Number: 10/620,560 Examiner: OLSEN

Filed: 17 July 2003

For: **SOLUTIONS AND PROCESSES FOR REMOVAL OF SIDEWALL RESIDUE AFTER DRY ETCHING**

BRIEF ON APPEAL UNDER 37 C.F.R. § 41.37

Mail Stop - **Appeals**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an appeal from the decision of the Examiner finally rejecting claims 13-21 and 24-27 of the above-identified application.

(1) REAL PARTY IN INTEREST

The application is assigned of record to BASF Aktiengesselschaft, who is the real party in interest herein.

(2) RELATED APPEALS AND INTERFERENCES

Appellants, their legal representative and the assignee are not aware of any related appeals or interferences, which will directly affect or be directly affected by or have a bearing on the Board's decision in the instant appeal.

(3) STATUS OF THE CLAIMS

Claims rejected:	Claims 13-21 and 24-27
Claims allowed:	(none)
Claims canceled:	Claims 1-12 and 22-23
Claims withdrawn:	(none)
Claims on Appeal:	Claims 13-21 and 24-27 (Copy of claims on appeal in attached Appendix).

(4) STATUS OF AMENDMENTS

The Examiner did not enter the Amendment and Reply after Final Rejection for the purposes of this appeal; see the Advisory Action mailed 18 April 2007.

(5) SUMMARY OF CLAIMED SUBJECT MATTER

Appellants' invention is directed to a process for selectively removing silicon dioxide and photoresist sidewall residue after dry etching of a semiconductor wafer comprising treating the wafer after dry etching with a solution consisting essentially of;

(a) sulfuric acid,

(b) hydrogen fluoride, ammonium fluoride or an alkali metal fluoride, and

(c) hydrogen peroxide,

wherein said solution contacts said sidewall residue effectively to remove it from said dry etched wafer, and wherein the ratio (a):(b) is in the range of from 10:1 to 700:1 by weight (see, for example, claim 13 and page 3, lines 32-35). The photoresist is effective for g-line, i-line, deep UV, E-beam or X-ray (see, for example, claim 14 and page 4, line 30). Preferably, the wafer is treated at a temperature of from 0 to 140°C (see, for example, claim 15 and page 4, line15). Most preferably the wafer is treated at a temperature of from 120 to 140 °C (see, for example, claim 19 and page 4, line 15). The wafer is treated for about 10 minutes (see, for example, claim 16 and page 4, line 16) at an operation pressure of about 1 atm (see, for example, claim 17 and page 4, line 16) resulting in an etch rate of the wafer of less than 1 Å/min (see, for example, claim 18 and

page 4, line 19). Most preferably component (b) is hydrogen fluoride (see, for example, claim 20 and page 2, lines 25-30). Also preferred is a solution where the ratio (a):(b) is in the range of from 100:1 to 700:1 by weight (see, for example, claim 24 and page 3, line 34). Most preferably, the ratio (a):(b) is in the range of from 300:1 to 500:1 by weight (see, for example, claim 25 and page 3 line 34 to page 4, line 1). Also preferred is a ratio of sulfuric acid plus ammonium fluoride to hydrogen peroxide of 3:1 by volume (see, for example, claim 26 and page 6, lines 1-17). In another embodiment of the invention (b) is preferably ammonium fluoride or an alkali metal fluoride (see, for example, claim 27 and original claims 4 and 6).

The invention further relates to a process for selectively removing silicon dioxide and photoresist after dry etching of a semiconductor wafer comprising treating the wafer after dry etching with a solution consisting essentially of sulfuric acid, hydrofluoric acid and hydrogen peroxide wherein the ratio of sulfuric acid plus hydrofluoric acid to hydrogen peroxide is 3:1 by volume (see, for example, claim 21 and page 6, lines 1-17).

(6) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The following outstanding grounds of rejection are requested to be reviewed on appeal. Any separate consideration of the claims subject to this rejection is indicated.

1. The rejection of claims 13, 15, 16, 18-20, 24, 25 under 35 U.S.C. §102, for allegedly being anticipated by Ohnishi (EP0618612A2) or in the alternative under 35 USC §103 as obvious over Ohnishi.

2. The rejection of claims 14, 17, 21 and 26 under 35 USC §103 for allegedly being obvious over Ohnishi.

(7) ARGUMENT

1. Rejection Under 35 U.S.C. §102(b) and §103 of claims 13, 15, 16, 18-20, 24 and 25

Claims 13, 15, 16, 18-20, 24, 25, on appeal, are not anticipated by Ohnishi (EP0618612A2) or in the alternative are not obvious to one of ordinary skill in the art over Ohnishi. Thus, the rejection of the claims under 35 U.S.C. §102 and §103 is not supported and should be reversed.

(a) There is no anticipation

Ohnishi (EP 618 612) teaches a cleaning technique used to remove contaminants such as organic residues, inorganic residues, other residues, and particles from a surface of a semiconductor substrate (see column 2, lines 47-56). Ohnishi adds fluorosulfuric acid to sulfuric acid in order to generate HF by the reaction with water molecules which are present in the solution. Hydrogen peroxide is added to achieve a constant etching rate.

At the bottom of page 2 bridging page three of the final Office Action the Examiner states "...similar results are obtained from Ohnishi's and Appellant's compositions, is would appear that Ohnishi's composition is comparable to the claims composition." As can be seen in Figure 3 and col. 5, lines 4-9 of Ohnishi, the Examiner's allegation is not correct. The etching results for HF and HSO_3F ("fluorosulfuric acid") are not the same. They do not etch in the same manner. Ohnishi does not teach the amount of HF that is produced in solution and as the Examiner correctly notes on page 2 of the final rejection, the amount of HF generated cannot be determined. Furthermore, as can be seen in Fig. 3 of Ohnishi, if the $HF+H_2SO_4$ were in equilibrium with HSO_3F $+H_2O$, the curves would be identical or at least parallel (due to differences in concentrations). As clearly depicted, this is not the case. Equilibrium is not reached and, thus, there is a difference between starting with HF and starting with HSO_3F. One skilled in the art could not conclude that a sufficiently high HF concentration could be reached when starting from HSO_3F.

As the Examiner correctly notes, Ohnishi does not explicitly teach the amount of HF that is produced in solution. The Examiner *believes* that the weight ratio between sulfuric acid and HF would be inherently present. But it is not enough for the PTO to "believe". More than speculation or belief must support the rejection. The Examiner cites *In re Best* (*In re Best*, 562 F.2d 1252, 1254-55, 195 USPQ 430, 433 (CCPA 1976)) to require the Applicant to prove that the subject matter shown to be in the prior art does not possess the characteristic relied upon. But *In re Best* requires that the PTO show it is reasonable to believe that the characteristic is possessed in the prior art, for the burden to shift to the applicant. In this case, however, the teachings of Ohnishi are so ambiguous that Appellants, like a skilled worker, would not be able to determine a reference solution with which to compare or from which to assume such possession. If one cannot determine the solution being taught, one cannot determine or presume the characteristics of that solution.

For example, the Examiner makes reference to Ohnishi's comparative example wherein a 1% hydrofluoric acid is added to a liquid mixture of $H_2SO_4$and H_2O_2 in a 5:1 ratio (see Col 7, lines 37+). The Examiner concludes that this corresponds to an H_2SO_4:HF (w/w) ratio of 300:1. This conclusion is unjustified. In order to determine if the comparative example satisfies the ratio of a:b in the claims, one would first have to know if the reference is teaching 1% of a standard 49% HF solution, a 1% HF solution or a 1% concentration of HF in the final solution. It cannot be determined whether the components of Ohnishi's solution are weight, volume or mole amounts. The Examiner contends that a skilled artisan would expect the ratios taught in Ohnishi to reflect a volume/volume relationship because it is customary when all components are liquid. Again, this is speculation. Appellants note that skilled artisans often refer to ratios of solution components by volume, weight or by moles. For example, US 4,921,572 teaches amounts/ratios of each etching solution component in grams and moles.

In the advisory action the Examiner states that the claimed H_2SO_4:HF ratio is met by the teaching of Ohnishi regardless of whether the skilled artisan applies a (v/v), (w/v), or (w/w) relationship to the concentration teachings of Ohnishi. Other then mere allegation, the Examiner provides no explicit reasoning for the record to justify this

conclusion. But, the PTO must show it is reasonable to conclude that the prior art possess the characteristic relied upon for the burden to shift to the applicant. *In re Best*, 562 F.2d 1252, 1254-55, 195 USPQ 430, 433 (CCPA 1976). In this case, there is no way to know the ratio of HF to H_2SO_4. Without knowing how much of the 1% HF solution was added to the H_2SO_4:H_2O_2 mixture it is impossible to know the final amount of HF in Ohnishi's comparative example. Ohnishi is not only ambiguous with regards to weight, volume or mole percentage ratios but is ambiguous with regards to the amount of 1%HF solution that was added to the H_2SO_4:H_2O_2 mixture.

b) There is no obviousness

Furthermore, a skilled worker would not be motivated to modify the teachings of Ohnishi to arrive at the present invention. Ohnishi teaches a skilled worker that (HSO_3F) or SO_2F_2 are used **"instead** of using hydrofluoric acid." (Col. 2, lines 47-52). This is a teaching to eliminate use of HF. Furthermore, Ohnishi's figure 3, which directly compares HSO_3F and HF, teaches a skilled worker that HSO_3F and HF do not etch in the same manner. Ohnishi teaches away from the use of HF, since Ohnishi teaches a skilled worker to add fluorosulfuric acid (HSO_3F) or SO_2F_2 to sulfuric acid in order to generate HF by reaction with water molecules, which are present in the solution.

Thus, the reference fails to teach or suggest a process for removing sidewall residue after dry etching with a solution consisting essentially of sulfuric acid, a fluorine containing compound which is hydrogen fluoride, ammonium fluoride or an alkali metal fluoride, hydrogen peroxide and water, where the weight ratio of sulfuric acid to the fluorine-containing compound is 10:1 to 700:1. Additionally, the inherent properties of the solutions of Ohnishi cannot be determined based on the anemic teachings of Ohnishi with regards to the amounts of each component in the solution composition.

Not only is the Ohnishi reference ambiguous but also teaches away from the present invention. Thus, it is respectfully requested that the rejections of Claims 13, 15, 16, 18-20, 24, 25 under 35 U.S.C. §102 and §103 are not supported and should be reversed.

2. The rejection of claims 14, 17, 21, 26 under 35 USC §103

The rejection of claims 14, 17, 21, 26 on appeal are not obvious to one of ordinary skill in the art over Ohnishi (EP0618612A2).

Claims 14, 17 and 26 depend from and include all the limitations of claim 13 discussed above. Thus, the comments above with regards to claim 13 apply equally to claims 14, 17 and 26. With respect to claim 21 the ratio of sulfuric acid plus hydrofluoric acid to hydrogen peroxide is 3:1 by volume. Thus, the etching solution is 25% by volume hydrogen peroxide. Ohnishi's comparative example wherein a 1% hydrofluoric acid is added to a liquid mixture of $H_2SO_4$and H_2O_2 in a 5:1 ratio (see Col 7, lines 37+) clearly does not meet teach a solution having 25% by volume hydrogen peroxide and there is no hint or suggestion within Ohnishi to lead a skilled worker to increase the amount of hydrogen peroxide.

At page 5 of the final rejection the Examiner states that "...concentration limitations are obvious absent a showing of criticality." In the case of the present invention, as exemplified in the solution used in Examples 2 and 3 at page 6 of the specification, the sidewall passivation and photoresist were removed completely after dry etching in a single step process without affecting the Poly-Si and bottom SiO_2 substrate layer. The concentrations of the various components of Appellants' invention are important and advantageously avoid attacking the bottom oxide layer of the substrate and yet still completely remove sidewall residue. As noted above, Ohnishi directly compares HSO_3F and HF, and shows they do not etch in the same manner. Thus, it cannot be assumed that the composition of Ohnishi would remove sidewall passivation and photoresist completely after dry etching without affecting the Poly-Si and bottom SiO2 substrate layer.

Furthermore, the Ohnishi reference is unclear with regards to the concentrations of the various components and would not lead one skilled in the art to arrive at the present invention. Nor does the reference provide a clear teaching of a solution against which appellants could compare their claimed invention.

Ohnishi is silent regarding an etching solution where the ratio of sulfuric acid plus hydrofluoric acid to hydrogen peroxide is 3:1 by volume. Nor is there any suggestion for one skilled in the art to modify the teachings of Ohnishi to arrive at the present invention.

Additionally, the inherent properties of the solutions of Ohnishi simply cannot be determined based on the anemic disclosure of Ohnishi with regards to the amounts of each component in the solution composition.

Thus, the rejection under 35 U.S.C. §103 is not supported and should be reversed.

The Commissioner is hereby authorized to charge any fees associated with this response or credit any overpayment to Deposit Account No. 13-3402.

Respectfully submitted,

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CLAIMS APPENDIX

1-12. (Cancelled)

13. (Previously presented) A process for selectively removing silicon dioxide and photoresist sidewall residue after dry etching of a semiconductor wafer comprising treating the wafer after dry etching with a solution consisting essentially of;

(a) sulfuric acid,

(b) hydrogen fluoride, ammonium fluoride or an alkali metal fluoride, and

(c) hydrogen peroxide,

wherein said solution contacts said sidewall residue effectively to remove it from said dry etched wafer,
and wherein the ratio (a):(b) is in the range of from 10:1 to 700:1 by weight.

14. (Previously presented) A process for removing photoresist according to claim 13, wherein the photoresist is effective for g-line, i-line, deep UV, E-beam or X-ray.

15. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the wafer is treated at a temperature of from 0 to 140 degrees C.

16. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the wafer is treated for about 10 minutes.

17. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the operation pressure is maintained at about 1 atm.

18. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the etch rate of the wafer is less than 1 Å/min.

19. (Previously presented) A process for removing photoresist after dry etching according to claim 15, wherein the wafer is treated at a temperature of from 120 to 140 degrees C.

20. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein (b) is hydrogen fluoride.

21. (Previously presented) A process for selectively removing silicon dioxide and photoresist after dry etching of a semiconductor wafer comprising treating the wafer after dry etching with a solution consisting essentially of sulfuric acid, hydrofluoric acid and hydrogen peroxide wherein the ratio of sulfuric acid plus hydrofluoric acid to hydrogen peroxide is 3:1 by volume.

22. (Cancel)

23. (Cancel)

24 (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the ratio (a):(b) is in the range of from 100:1 to 700:1 by weight.

25. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the ratio (a):(b) is in the range of from 300:1 to 500:1 by weight.

26. (Previously presented) A process for removing photoresist after dry etching according to claim 13, wherein the ratio of sulfuric acid plus ammonium fluoride to hydrogen peroxide is 3:1 by volume.

27. (Previously presented A process for removing photoresist after dry etching according to claim 13, wherein (b) is ammonium fluoride or an alkali metal fluoride.

EVIDENCE APPENDIX

(none)

RELATED PROCEEDINGS APPENDIX

(None)